be two opinions as to the abstract desirability of a cadastral survey; that it would be difficult to conceive a greater boon to the province than would be the existence at the present moment of a complete series of cadastral maps, with their accompanying detailed records of possession and of title; that to measure the extent to which such a record would facilitate administration and promote economic progress, it is only necessary to realise the vast quantity of interminable litigation, more or less connected with the land, that burdens the civil and criminal courts, and drains the resources of the agricultural population. Out of the many criminal cases, true or false, that are brought to determine questions of title or possession in village fields—out of the concurrent and still more harassing civil litigation on the same subject—a very great proportion would certainly never have arisen at all, but for the lack of survey records, and in the remainder the same lack places equity and justice at an extreme disadvantage, and prevents the decisions arrived at from being accepted as definitive. The criminal courts decide at most the question of actual possession at the moment: the parties accept the situation for the time, and go away poorer, but not wiser, to renew the contest when opportunity and resources offer. The civil courts work in the dark, sending out "amins" to perform straggling fragments of mapping—the outcome of hearsay and village tradition rather than of any scientific process—which barely serve as precarious foundations for the court's decree, and do not secure the ready identification of the site when the litigation is in course of time reopened. There is nowhere any stand-point of knowledge or certainty, and every transaction in connection with land is either a litigation or a compromise, in which the strongest wins.

But the cleansing of this Augean stable is expected to be a work of extreme magnitude and difficulty. A Commissioner, who is entirely in favour of the experimental introduction of cadastral survey operations, reports that both zamindars who continue to levy rates which have been actually disallowed in courts of justice, and ryots who for years have taken advantage of the absence of a record to hold more land than they pay rent for, are interested in many instances in preventing the truth from being found out, and the appearance of the survey party in any estate will awaken all sorts of fraud and chicanery, all that procrastination, evasion, and quiet opposition at which both zamindars and ryots are such great adepts. To this must be added the opposition which will be offered by interested middlemen of all grades. The cadastral survey will be an opening up of all the sores of the country, a probing of old wounds, and an invitation to all and sundry to come forward and join in the great game of scrambling for rights; for in Bengal there is next to nothing to go upon.

Thus a cadastral survey will not be an unmixed blessing, and there are not a few of the higher officials who think it likely to be exceedingly mischievous, and deprecate its being undertaken. It is strongly opposed by all the more powerful zamindars. Still it is probably more alarming in prospect than it will prove to be in reality. With a view to the acquisition of practical experience on the subject, the Government has ordered a cadastral survey of the district of Mozuffurpur, which lies to the north of Patna, to be immediately undertaken as a tentative measure. J. T. W.

(To be continued.)

AËRIAL NAVIGATION

THE account given in NATURE (p. 421) of the late experiments of the French Government with their "dirigible" balloon is very interesting and important, and in order to give it its full significance I will ask leave to offer a short explanation of the general state of the question.

In 1875 I had occasion, in writing an article on balloons for one of our leading Reviews, to call attention to the fact that some skilful and, so far as they went, successful attempts had been made not long before by two French engineers, MM. Henri Giffard and Dupuy de Lôme, to show the possibility of propelling and guiding balloons through the air.

At that time a general and strong opinion prevailed in England against such a possibility. This opinion was enunciated by various classes of people. In the first place, some writers, taking upon themselves to speak in the name of science, declared that the thing was physically impracticable. The Duke of Argyll, for example, the President of the Aëronautical Society of Great Britain, wrote:—[1]

"A balloon is incapable of being directed, because it possesses no active force enabling it to resist the currents of the air in which it is immersed, and because, if it had such a force, it would have no fulcrum or resisting medium against which to exert it. It becomes, as it were, part of the atmosphere, and must go with it wherever it goes."

Then another class of objectors were the aëronauts, who necessarily and properly commanded respect as experts in the practice of ballooning. The cleverest of these, Nadar, declared it was impossible to control the direction of balloons, on account of their lightness and large surface, and he laid down what he considered an important principle, that "pour lutter contre l'air, il faut être plus lourd que l'air." One of our most esteemed and experienced English aëronauts, Mr. Coxwell, held the same view; and another (now, alas! lamented) expert, Col. Fred. Burnaby, wrote in the *Fortnightly Review* of May 1884, an article on the "Possibilities of Ballooning," for the express purpose of asserting that the power of guiding them was not one of these possibilities. He professed to show that we were not "one whit nearer" the solution of this problem than when De Rozier and the Marquis d'Arlandes made the first ascent; he denied the truth of the French reports of what had been done; and he offered a present of 100*l.* to any one who, in a free balloon, would after travelling a certain distance return to his starting-point. And I may mention that so strong was the feeling in favour of Col. Burnaby's assertion, that the editor of the *Review* refused to insert a short and respectful remonstrance against it which I tendered to him. Then there were the host of writers in the general Press, the *Times* at their head, who argued that, as in the century since balloons had been invented nothing had been done, it was clear nothing could ever be done, and that the idea of guiding them must be a delusion, which was accordingly ridiculed unmercifully.

All this had an important practical effect; for our military authorities, who wished to make use of balloons in war, totally ignored all possibility of directing them, and confined their attention to using them captive for observing stations, as had been done in the battle of Fleurus nearly a century ago.

As it appeared to me that this opposition and incredulity were very ill-founded, and that the matter was worth more serious investigation, I sent to the Institution of Civil Engineers "A Study of the Problem of Aërial Navigation, as affected by Recent Mechanical Improvements," which they did me the honour to publish in the volume of their *Proceedings* for the session 1881-82. I attempted to show, in the first place, that the problem was perfectly amenable to mechanical reasoning, and that its successful solution involved nothing inconsistent with the teachings of mechanical science; secondly, I pointed out various reasons to account for the failure of early attempts to guide balloons; and thirdly, I showed that the result of the recent French experiments, when treated on ordinary mechanical principles, gave fair data for forming an approximate estimate of what might hereafter be done.

[1] "Reign of Law," London, 1868, p. 130.

They had sufficiently established the general practicability of the attempt, and they had obtained an actual speed through the air of about 6 miles an hour, and it was easy to argue that by suitable provisions this might be increased to 10, 20, or perhaps even 30 miles an hour.

Meantime the French, who had no insular prejudices to restrain them, continued their experiments. M. Gaston Tissandier, an eminent man of science as well as a skilled aëronaut, conceived the possibility of applying electrical power for balloon propulsion; he exhibited a working model at the Paris Electrical Exhibition of 1881, and afterwards made, at his own expense, a large balloon, with which in 1883 he obtained a velocity of 9 miles an hour. But the French military authorities (wiser in their generation than ours) here stepped in, and, with their greater resources, carried the trials still further. They commissioned two of their engineer officers, Messrs. Renard and Krebs, to construct a balloon with which the problem might be thoroughly worked out, and the result is now given. The experiment has been a perfect success; an independent velocity through the air has been attained of upwards of 13 miles an hour; the balloon has been managed, steered, and guided with the greatest ease, and it has, in defiance of the wind, been made to return to its starting-point, the test proposed by Col. Burnaby.

But the most valuable part of the communication to the Academy of Sciences has been the investigation of the bearing of the experiments on the scientific conditions of the problem. There were two points especially which, from the want of actual experience, had in former calculations to be estimated by analogy from water navigation: the resistance which a balloon would encounter at different speeds in its passage through the air, and the efficiency of the screw propeller in overcoming this resistance.

First, as to the resistance. M. de Lôme estimated this by the midship section, but in a vessel much elongated the length has also to be taken into account. Prof. Rankine has given a rule for ships according to the wetted surface, and also another dependent on the displacement. Adapting these to air, and making certain additions which M. de Lôme estimated as special to the balloon, I obtained for the resistance in lbs., the diameter and length being in feet, and the velocity in feet per second—

$$\text{By the skin friction } R = 0{\cdot}0000477 dlv^2;$$
$$\text{By the displacement } R = 0{\cdot}0000886(d^2l)^{\frac{2}{3}}v^2.$$

Now, taking the proportion of MM. Renard and Krebs's balloon at $l = 6d$, these equations become—

$$R = 0{\cdot}000286 d^2v^2,$$
$$\text{and } R = 0{\cdot}000292 d^2v^2.$$

The result of the latest French experiments is, when put in English measures—

$$R = 0{\cdot}000320 d^2v^2.$$

This is a little higher than the estimation by the former methods, but it corresponds sufficiently well to give confidence in the general mode of inquiry.

Secondly, as to the efficiency of the screw propeller. This has been often investigated for water navigation, and it may be said that an efficiency of 70 per cent. is fairly borne out by experience. MM. Renard and Krebs obtain for their screw an efficiency of only about 50 per cent.

It is, I should think, highly probable that by further experience both these elements may be considerably amended; but even taking the facts as they are, they show the attainment of considerably higher speeds to be perfectly practicable. A balloon of 50 feet diameter, for example, would carry power sufficient to give a speed of upwards of 20 miles an hour, and still leave a considerable buoyancy disposable.

At any rate, let us hope that we may have no more quasi-scientific declarations of the impossibility of propelling and guiding balloons, and no more sneers at those who attempt to solve the problem. The capabilities of aërial locomotion of this kind must (as I have fully shown elsewhere) be necessarily limited, but its utility in certain situations would be incontrovertible. The President of the Institution of Civil Engineers, Sir F. Bramwell, speaking in January 1885, said:—

"There may undoubtedly be particular circumstances in which this mode of locomotion would be useful, such, for example, as the exploration of new countries, or as the present Egyptian campaign. I strongly suspect that if our lively neighbours, instead of ourselves, had been invading the Soudan, they would long before this have had a dirigible balloon looking down into Khartoum."

And we have now a curious comment on his words, as we know that at that very time there was, lying in its shed near Paris, a balloon which, though perhaps it could not have saved Gordon, might certainly have saved poor Burnaby, and otherwise have been of incalculable benefit to our military operations. WILLIAM POLE

MEDICAL STUDY IN OXFORD

STATUTES for the regulation of the qualifications of Candidates for Degrees in Medicine and Surgery, and for creating a Faculty of Medicine in the University of Oxford, have after prolonged discussions been approved by Congregation in their definitive form. The Statute which places the medical studies of the University under the control of the new Board of the Faculty of Medicine recently received the final sanction of Convocation, and the other statutes will soon follow. The interest which these Statutes have excited could certainly not be attributed to the radical nature of the changes which they will initiate. It must be rather due to the circumstance that the establishment of the new Faculty is regarded as an indication that Oxford, which has hitherto stood alone as the only University in the United Kingdom which has no mdeical students, and in which there is no organisation for medical instruction, now intends to undertake this function.

It is well known that the Oxford Medical Degree is one of the most coveted professional distinctions, but it does not, like that of Cambridge or Edinburgh, mean that the possessor of it has been trained either in science or in medicine at Oxford. In future there is reason to hope that it will be otherwise—that the University will no longer confine itself to the giving of degrees, but will teach all those branches of medical knowledge which come within the range of University studies.

Chemistry, human anatomy, and physiology, are the three subjects which constitute the scientific foundation of medical education, the last-mentioned being itself founded on the other two. For the instruction of medical students in human anatomy, the University has lately imported from Edinburgh an accomplished and experienced teacher, Dr. Arthur Thomson, who has already as many pupils as he can find room for; and the completion of the new laboratory has rendered possible the development of practical work in physiology. But the mere providing of the means of instruction in these subjects is insufficient, unless the lectures and laboratory work are so systematised as to enable the student to learn all that he needs to learn within the limited time at his disposal, and at the same time each branch of teaching is sufficiently specialised to adapt it to his requirements.

The bearing of the new statutes on medical education in the University can be best understood in relation to the course of scientific training which an intending student of medicine will, if they are passed, be able to follow. Hitherto the Oxford graduate who has obtained